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Canadian Science Advisory Secretariat
Science Advisory Report 2013/045

2013 ASSESSMENT OF 4VWX HERRING

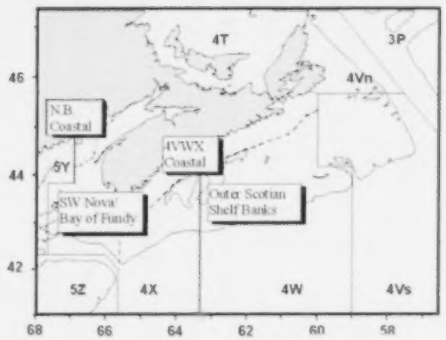

Figure 1. 4VWX herring management area and stock component locations.

Context:

In support of scientific advice for the 2012/13 and 2013/14 fisheries, the 2013 assessment of the 4VWX herring stock complex was reviewed through a Science Advisory Process. The meeting was held March 26-27, 2013, in Dartmouth, N.S. to review and evaluate biological and fishery information on 4VWX herring status as a basis for establishing quota for the 2012/13 fisheries, as required in the Integrated Fisheries Management Plan. The terms of reference included an evaluation of the Southwest Nova Scotia (SWNS)/Bay of Fundy spawning component, compilation and review of information regarding the offshore Scotian Shelf and the coastal Nova Scotia spawning components, an update on southwest New Brunswick migrant juvenile fishery component, and recommendations to management on stock status. Participants included scientists, fishery managers, representatives of the industry, provincial governments, and other stakeholders. The last assessment of this resource was in 2011.

The 2003 (Evergreen) Scotia-Fundy Herring Integrated Fisheries Management Plan (IFMP) set out principles, conditions, and management measures for the 4VWX herring fisheries (DFO 2003). The main principle stated in the plan is "the conservation of the herring resource and the preservation of all of its spawning components". Three conservation objectives appear in the plan:

1) *To maintain the reproductive capacity of herring in each management unit through:*
   - *persistence of all spawning components in the management unit;*
   - *maintenance of biomass of each spawning component above a minimum threshold;*
   - *maintenance of a broad age composition for each spawning component; and*
   - *maintenance of a long spawning period for each spawning component.*

2) *To prevent growth overfishing:*
   - *continue to strive for fishing mortality at or below F0.1.*

3) *To maintain ecosystem integrity/ ecological relationships ("ecosystem balance"):*
   - *maintain spatial and temporal diversity of spawning; and*
   - *maintain herring biomass at moderate to high levels.*

Progress against these objectives was evaluated at this meeting. Since 1995, the herring stock assessment and related research has been increasingly dependant on a number of projects undertaken with the assistance of the fishing industry. These include industry sampling of biological characteristics of the catch, as well as acoustic surveys using industry vessels and tagging. A major review of the assessment framework was conducted 2006/07 (DFO 2007) followed by a framework meeting 2011. No model was chosen but recommendations for the assessment were provided in the report (DFO 2011). In

2012, a conservation limit reference point was set for spawning biomass in Scots Bay and German Bank to be evaluated based on the three-year moving average (Clark et al. 2012).

SUMMARY

SW Nova Scotia / Bay of Fundy

- Landings for the 2010/2011 and 2011/2012 quota years were 50,010t and 47,614t against a Total Allowable Catch (TAC) of 50,000t each year for the SW Nova Scotia/Bay of Fundy component. Landings have tracked the TAC since 2002, with most of the quota being taken each year since 2002. In 2010, as a result of an industry decision late in the season 9,466t of quota was left in the water. Since 2010 there have been self imposed measures by industry to monitor and regulate catches of fish less than 18cm.
- Acoustic survey catch at age had a broad age distribution of spawning fish from ages 3-11. There was a broader distribution of age-classes in the commercial catch at age than the acoustic survey catch at age. The proportion of fish at age 6 and older was 19% (2011) and 30% (2012) in the acoustic survey catch at age compared with 9% (2011) and 14% (2012) in the fishery.
- The overall acoustic biomass estimates (Scots Bay, Trinity Ledge and German Bank) increased in 2011 to 448,771t (44% over 2010) and further increased in 2012 to 476,026t (6% over 2011). This moves the overall acoustic biomass estimate to above the long term average (1999-2012).
- There has been a trend of declining mean weight at age. Declining trends in mean weight at age since the 1970s have reduced productivity of the stock.
- The three-year moving average for the acoustic survey estimate (Scots Bay and German Bank combined) in 2009 was calculated to be below the limit reference point by 5%. The three-year moving average increased to above the limit reference point in 2010 by 10%, in 2011 by 9% and in 2012 by 19%. The 2011 acoustic survey estimate increased to reach the long term average while the 2012 acoustic survey estimate increased to 7% above the long term average. The three-year moving average increased above the limit reference point in 2010 and changed very little in 2011 but then increased again in 2012.
- A harvest strategy which continues to exercise caution is appropriate.

Offshore Scotian Shelf Banks

- Since 1996, a fishery has taken place on feeding aggregations on the offshore banks of the Scotian Shelf, primarily in May and June, with catches ranging from 1,000 to 20,000t. In 2011, total landings were above average at 10,455t, down from 11,862t in 2010. In 2012, only 1,210t were landed from the offshore.
- No industry surveys were conducted on the offshore Scotian Shelf in 2011 or 2012.
- The industry is again encouraged to explore and undertake structured surveys of the offshore area.
- There was no new information and no reason to change the recommendation that the initial catch allocation for 2013 should not exceed 12,000t as described in the DFO management plan.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia

- Landings and allocations in the Little Hope/Port Mouton area have decreased since 2009. In 2011, 2,564t were landed against an allocation of 2,094t and in 2012, 2,150t were landed against an allocation of 2,188t. Landings decreased from 6,045t in 2009 to 799t in 2012 in the Eastern Shore area while the allocation also decreased from 3,857t to 2,920t during the same time period.
- The survey biomass in the Halifax/Eastern shore area saw a large decrease in 2010 declining to 27.7kt. This trend continued into 2011 (5.5kt) and 2012 (3.7kt) to the lowest since surveys started and well below the recent five year average of 24.3kt.
- Collaborative surveys with industry have improved our knowledge of two areas (Little Hope/Port Mouton, Halifax/Eastern Shore), but there has been no increase in information from other areas. Surveying in the Glace Bay area concluded in 2011. It is again recommended that no coastal spawning group experience a large effort increase in new areas until enough information is available to evaluate the state of that spawning group.
- It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern, but there has been no research or surveying in recent years. It is; therefore, appropriate to reiterate that no fishing should take place on this spawning component.
- Harvest levels from these areas use a five year average of recent catches and/or surveyed acoustic biomass to set initial targets.

SW New Brunswick Migrant Juvenile

- The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy. These fish are considered to be a mixture of juveniles, dominated by those originating from Northwest Atlantic Fisheries Organization (NAFO) Subarea 5 spawning components, and have, therefore, been excluded from the SW Nova Scotia/Bay of Fundy quota.
- Landings in New Brunswick weir and shut-off fishery were down dramatically from 10,958t in 2010, to 3,711t in 2011 and 504t in 2012. The 2012 catch is the lowest in the history of the fishery. It is notable that as recently as 2007 landings were 30,944t, the highest in nearly 20 years and higher than the long term average of 23,560t.
- Fish caught in the New Brunswick weir and shutoff fishery were mostly juveniles (54% at age 2 in 2011 and 80% at age 1 in 2012).
- The number of weirs with catches decreased in 2011 and 2012, with only 37 weirs reporting catches in 2011 and four weirs in 2012.
- The success of this passive fishery is historically unpredictable, and catches are extremely susceptible to many natural variables in addition to abundance.

BACKGROUND

Species Biology

Atlantic herring (*Clupea harengus*) is a pelagic species found on both sides of the North Atlantic. Herring spawn in discrete locations to which they have a strong affinity. Herring mature in 4VWX and first spawn at three or four years of age, then begin an annual pattern of spawning, over-wintering, and summer feeding. This often involves considerable migration and mixing with members of other spawning components and stocks. Fishing takes place on dense summer

feeding, over-wintering, and spawning aggregations. The majority of herring in the 4VWX area are fall spawners.

The 4VWX management unit contains a number of spawning areas, separated to various degrees in space and time. Spawning areas in close proximity with similar spawning times, and which share a larval distribution area, are considered part of the same component. These undoubtedly have much closer affinity than spawning areas that are widely separated in space or time, and do not share a common larval distribution. Some spawning areas are large and offshore, whereas others are small and more localized, sometimes very near shore or in small embayments. The stock structure is complicated further as herring migrate long distances and mix outside of the spawning period both with members considered part of the same component and with members of other components. For the purposes of evaluation and management, the 4VWX herring fisheries are divided into four components:

1. *SW Nova Scotia / Bay of Fundy spawning component*
2. *Offshore Scotian Shelf banks spawning component*
3. *Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia spawning component*
4. *SW New Brunswick migrant juveniles*

Each component except southwest (SW) New Brunswick migrant juveniles has several spawning areas, and there is mixing of fish among spawning components outside of the spawning period.

Fishery

Fisheries in 4VWX have been dominated by purse seine (84-90%), followed by weir, gillnet, shutoff and trap.

Landings for the 2010/2011 and 2011/2012 quota years were 50,010t and 47,614t against a Total Allowable Catch (TAC) of 50,000t each year for the SW Nova Scotia/Bay of Fundy component (Table 1). Landings have tracked the TAC since 2002, with most of the quota being taken each year since 2002. In 2010, as a result of an industry decision late in the season 9,466t of quota was left in the water (Figure 2). Since 2010, there have been self imposed measures by industry to monitor and regulate catches of fish less than 18cm.

Table 1. Reported landings (thousands of tonnes) and TAC for the 4WX herring management unit by component from 2005 to 2012 with averages for recent and prior decades.

Year	Average 1970-79	Average 1980-89	Average 1990-99	Average 2000-09	2005	2006	2007	2008	2009	2010	2011	2012
4WX SW Nova Scotia TAC[1]	106	106	112	69	50	50	50	55	55	55	50	50
4WX SW Nova Scotia[1]	131	131	96	66	49	50	50	55	54	46	50	48
4VWX Coastal NS[2]	<1	<1	4	7	7	7	5	4	10	6	4	3
Scotian Shelf Banks[2]	38	<0.1	13	6	5	10	5	1	9	12	10	1
SW New Brunswick[2]	26	24	24	15	13	13	31	6	4	11	4	1
Total Landings	172	155	137	93	74	79	92	66	77	74	68	52

1 - Quota year from Oct. 15 of the preceding year to Oct 14 of the current year

2 - Calendar year from Jan. 1 to Dec. 31

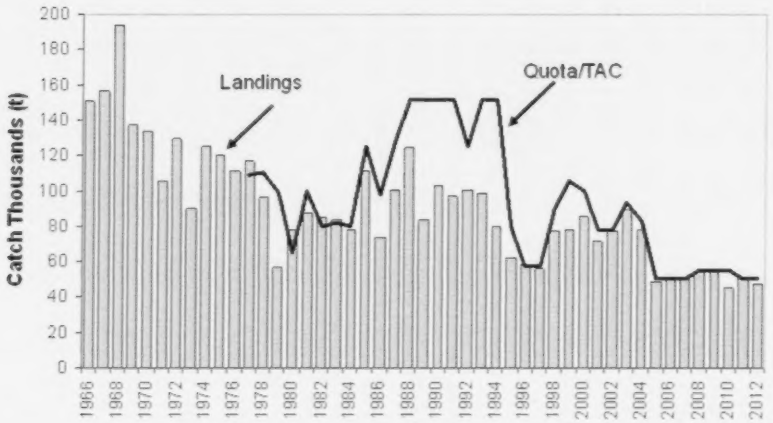

Figure 2. Landings (thousands of tonnes) and TAC for the SW Nova Scotia/Bay of Fundy spawning component.

Additional landings of 17,799t (2011) and 4,767t (2012) were taken in the non-stock components (outside the quota area) for a total of 67,809t in 2011 (down from 73,929t in 2010) and 52,381t in 2012 (significantly down again from the 2011 landings). Landings decreased from the New Brunswick weirs and shutoffs as well as the Scotian Shelf Banks and the Coastal Nova Scotia component. Purse seine catches by fishing grounds were similar to 2010 with the largest proportions reported from the German Bank (45% in 2011 and 65% in 2012), Grand Manan (26% in 2011, but only 9% in 2012), and Scots Bay (11% in both 2011 and 2012) areas. There were also increases in catches by tonnage and relative proportions from the Lurcher, Trinity and Gannet Dry Ledge areas. Of significant note was that in 2012 less than 1% of reported purse seine catches originated from New Brunswick Coastal fishing grounds compared with 4% reported in 2011.

Industry and management have explored means of managing the complexity within each component (such as distributing fishing effort among spawning areas according to their relative size) and taking account of the interaction among components (such as fishing restrictions on some areas of mixing). Prior to 2005, there was targeting of young fish and the high proportion of juveniles in the catch resulted in lost potential yield. Since 2005, industry has made a concerted effort to avoid small fish. From 2005 to 2008, the total removals by number were reduced by close to 50% relative to 2004; however they increased in 2009 with the catch of a large proportion of 2 year olds (45%) by number.

The total removals of 2 year olds increased from 263 million in 2009 to 482 million (83% increase) in 2010 and made up 60% of the overall TAC by number and 32% by weight. This was the largest percentage of two year-olds taken by the fishery since 1968. The mean age of the catch was 2.7 which was lower than the age at first maturity and one of the lowest observed.

The strong 2010 age 2 cohort (2008 year-class) was reflected in the strong age 3 cohort in 2011 (46%) and continued to show up in 2012 as 4 year olds (27%). The lack of a strong age 2 cohort (12%) in 2011, showed up as age 3 (13%) in 2012 and is a cause for concern since they will become the age 4 cohort in 2013.

ASSESSMENT FOR THE SOUTHWEST NOVA SCOTIA/BAY OF FUNDY SPAWNING COMPONENT

In the 2008-2009 quota year, the fishery catch at age was comprised of 45% fish by number at 2 years of age and 7% older than age 5. In the 2009-2010 quota year, there were 60% fish by number at age 2 and only 3% older than age 5 in the catch. This decrease of older/larger fish in the catch cannot be explained by just the very high proportion of 2 year olds. The 2005 year-class at age 5 was prominent in the 2009-2010 catch and continued to be seen at age 6 in 2010-2011 (8%) and as 7 year olds in 2011-2012 (4%) Figures 3 and 4). In 2010-2011, age 3 fish made up 46% of the catch by number and showed up in 2011-2012 as 4 year olds at 27% implying that 2008 was a good year for recruitment. Two year olds in 2011-2012 (25%) do not appear to be as strong as the 2008 year-class or as widespread as in 2009-2010.

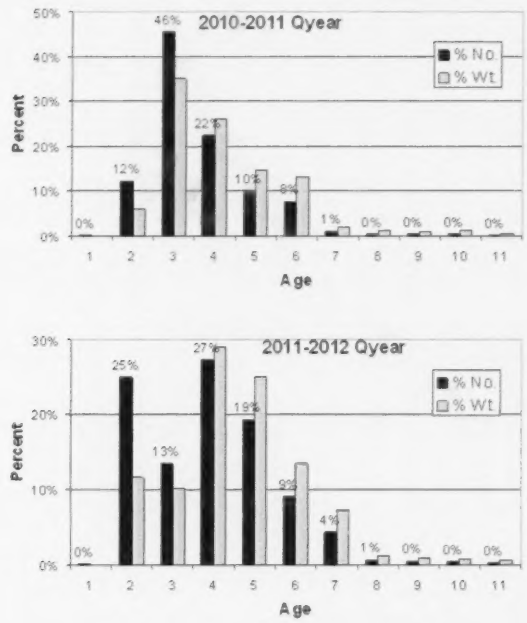

Figure 3. Fishery catch at age (% numbers and % weight) for SW Nova Scotia/Bay of Fundy spawning component (2010-11, 2011-12 quota years).

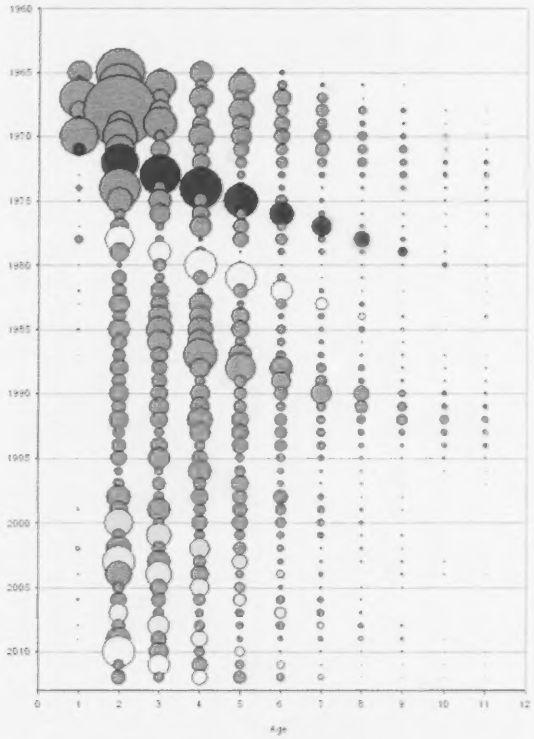

Figure 4. Historical catch at age for SW Nova/Bay of Fundy spawning component from 1965-2012. Selected year-classes are indicated by colours.

The total number of fish removed by the fishery was calculated to be 796 million (2010), down to 498 million (37%) in 2011 and then down further to 432 million (13%) in 2012 suggesting the harvesting of larger fish.

The acoustic surveys document primarily spawning fish (age 3 and older) with an age composition that is different from the fishery. Acoustic survey catch at age had a broad age distribution of spawning fish from ages 3-11. There was a broader distribution of age-classes in the commercial catch at age than the acoustic survey catch at age. The proportion of fish at age 6 and older was 19% (2011) and 30% (2012) in the acoustic survey catch at age compared

with 9% (2011) and 14% (2012) in the fishery. The mean age of the acoustic survey catch at age decreased from 4.8 years in 2010 to 4.3 in 2011 and increased to 5.1 years in 2012 (Figure 5). A mean acoustic survey catch at age higher than the mean age in the commercial catch in 2012 implies older fish.

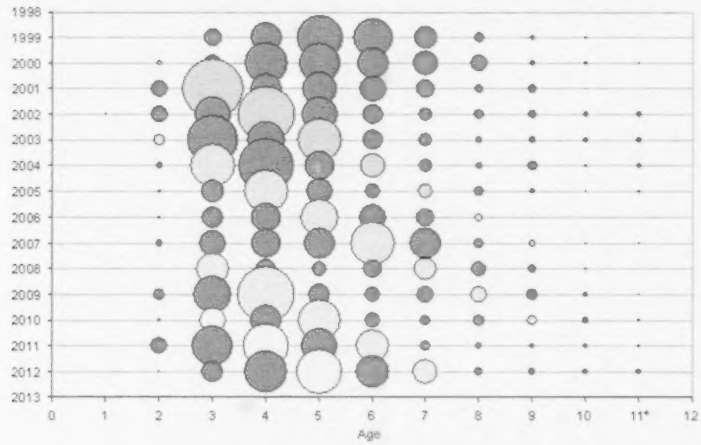

Figure 5. Acoustic survey age composition for the overall SW Nova/Bay of Fundy spawning component.

Acoustic Surveys

Industry led surveys with automated acoustic recording systems deployed on commercial fishing vessels were used to document the distribution and abundance of spawning herring. Scheduled surveys were conducted approximately every 2 weeks on the main spawning grounds and an index of spawning stock biomass (SSB) for each component was estimated by summing these results (Table 2) (Figure 6).

Table 2. Acoustic survey spawning biomass index for SW Nova Scotia / Bay of Fundy spawning component for 1999 to 2012 (thousands of tonnes).

Location/Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Average 2005-2010	Average 1999-2012
Scots Bay (inbox)	46	185	216	129	123	115	21	32	51	23	82	42	106	144	42	94
Scots Bay (outbox)									2	0	6	12	35	41	11	16
Scots Bay total	46	185	216	129	123	115	21	32	53	23	88	54	141	185	45	101
German Bank (inbox)	495	334	257	416	349	392	269	291	495	239	396	235	289	278	321	338
German Bank (outbox)								5	4	2	2	19	11	10	6	8
German Bank total	495	334	257	416	349	392	269	295	499	241	398	254	300	288	326	342
Trinity Ledge	4	1	15	9	12	12	11	16	3	1	2	2	7	3	6	7
Spec Buoy (spring)			1		1		1		0	0		2	0		1	1
Spec Buoy (fall)			88					0							0	44
Overall Stock Area	545	521	577	554	485	519	301	343	556	265	487	312	449	476	377	456
Seal Island			4	1	12			10					1		10	6
Browns Bank			45					8							8	26
Total All Areas	545	521	626	556	497	519	301	361	556	265	487	312	450	476	380	462

Six surveys were conducted in Scots Bay in 2011 and five in 2012. Five (2011) and six (2012) surveys were conducted on German Bank, all of which were used to estimate SSB. Individual survey area coverage was good and consistent with established protocols.

The amount of spawning fish documented on Trinity Ledge in 2011 was up from 2,405t in 2010 to 7,316t, but down to 2,754t in 2012. Survey coverage was very limited with 3 surveys completed on small areas of spawning fish in 2011 and 2012. Surveying and sampling continues to be insufficient. There was one survey in 2011 around Seal Island but no samples were available. A biomass estimate for Seal Island of 1,472t was determined using German Bank samples to provide size information. There were no surveys on Browns Bank. A single spring survey on Spectacle Buoy in 2011 observed 282t.

The overall acoustic biomass estimates (Scots Bay, Trinity Ledge and German Bank) increased in 2011 to 448,771t (44% over 2010) and further increased in 2012 to 476,026t (6% over 2011) (Figures 6, 7). This moves the overall acoustic biomass estimate to above the long term average (1999-2012). Most of the increase is attributed to the large increase in SSB in Scots Bay from 54,000t in 2010 to 140,712t in 2011 then to 184,829t in 2012. The German Bank SSB increased from 253,800t in 2010 to 300,461t in 2011 then decreased to 288,443t in 2012, essentially representing no change over the past three years.

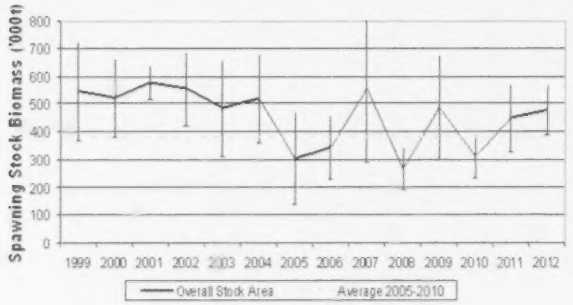

Figure 6. SSB index from acoustic surveys for the overall SW Nova Scotia/Bay of Fundy spawning component.

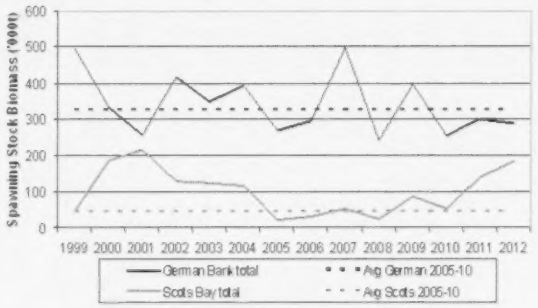

Figure 7. SSB index from acoustic surveys for Scots Bay and German Bank.

The three-year moving average for the acoustic survey estimate (Scots Bay and German Bank combined) in 2009 was calculated to be below the limit reference point by 5% (Figure 8). The three-year moving average increased to above the limit reference point in 2010 by 10%, in 2011 by 9% and in 2012 by 19%. The 2011 acoustic survey estimate increased to reach the long term average while the 2012 acoustic survey estimate increased to 7% above the long term average. The three-year moving average increased above the limit reference point in 2010, changed very little in 2011 but then increased again in 2012.

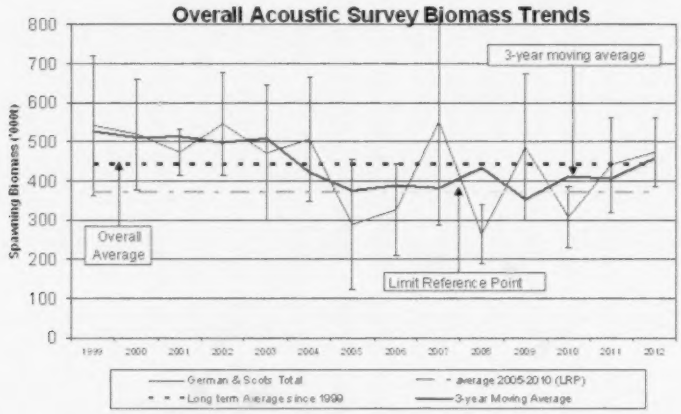

Figure 8. Relative spawning stock biomass index (with 95% standard errors), the calculated three year moving average, the long term average and the limit reference point for the SW Nova Scotia/Bay of Fundy spawning component (German Bank and Scots Bay).

Stock Trends and Current Status

Stock status and scientific advice for 4VWX herring is based on recommendations from the January 2011 framework (DFO 2011) and the 2012 Limit Reference Point meeting (Clark et al. 2012) as follows:

1. Report on criteria for survey and sampling and identify anomalies
2. Signs of change using the following indicators:
   a. survey biomass trends,
   b. fishermen input,
   c. numbers or proportion at age in catch and survey,
   d. trends in relative exploitation rates using catch and acoustic survey spawning biomass estimates,
   e. trends in total mortality rate (Z) are based on age composition, and
   f. the three-year moving average survey biomass (Scots Bay and German Bank) relative to the limit reference point.

The 4VWX herring advice is based on the observations and conclusions of the conservation objectives identified in the management plan (DFO 2003) (Table 3).

Table 3. Observations and conclusions on conservation objective elements from the management plan for SW Nova Scotia / Bay of Fundy spawning component in 2011 and 2012.

Objective in the Management Plan	2011 and 2012: Observations and Conclusions
Persistence of all spawning components	Spawning was observed in Scots Bay and German Bank. No spawning was observed on Seal Island or Browns Bank. Trinity Ledge again had minimal spawning observed. The two major spawning components have persisted.
Maintain biomass of each component	Acoustic biomass estimates increased substantially for Scots Bay. German Bank SSB fluctuated up in 2011 and down in 2012, representing essentially no change. The SSB for Trinity remains low moving above the long term average in 2011 and dipping below 2012.
Maintain broad age composition	There is currently a broad range of ages in the commercial catch, representing an improvement. However, the proportion of older aged fish (>7 years old) remains small.
Maintain long spawning period	Start of spawning in 2012 for German Bank was earlier than 2011 based on survey results. Spawning in Scots Bay appeared to start and end about the same time in both years. This is earlier than in previous years. Virtually no spawning occurred on Trinity Ledge. Spawning periods are being maintained on the two major spawning grounds.
Fishing mortality at or below $F_{0.1}$	Fishing mortality could not be determined. Relative exploitation rates based on acoustic SSB and catch decreased in 2011 and 2012.
Maintain spatial and temporal diversity of spawning	Similar spatial and temporal distribution of spawning on German Bank. Duration of spawning in Scots was extended and similar to 2009. Trinity spawning is very restricted in space and time. There is a lack of documented spawning in other areas. Spawning periods are being maintained both temporally and spatially on the two major spawning grounds.
Maintain biomass at moderate to high levels	In 2011 the overall SSB (Scots Bay and German Bank combined) was slightly below the long term average (1999 to 2012) and in 2012 increased to above the average.
Maintain the index above the limit reference point	The three-year moving average increased above the limit reference point in 2010, changed very little in 2011, and increased again in 2012.

Observations on Mean Weight

There has been a trend of declining mean weight at age (Figure 9). Declining trends in mean weight at age since the 1970s have reduced productivity of the stock.

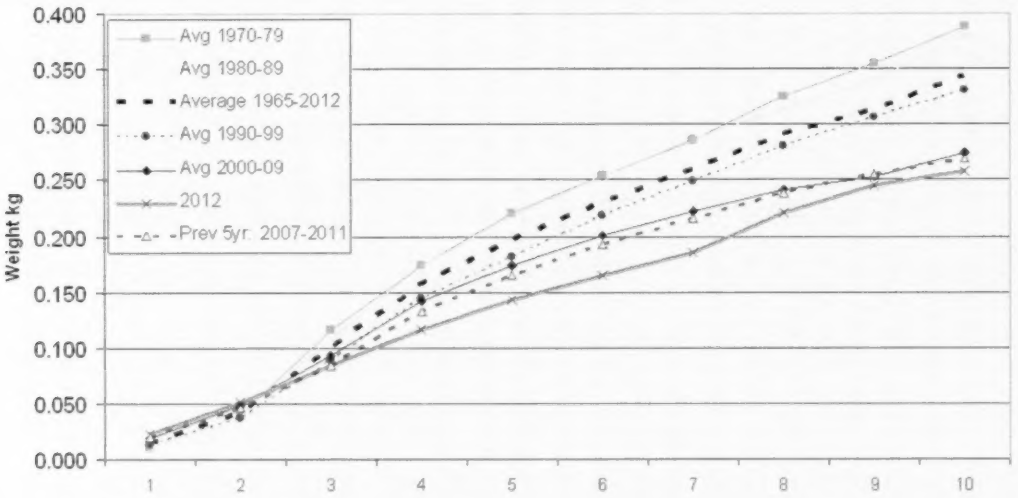

Figure 9. Fishery mean weights at age for 2012 season compared with the decadal averages, overall time series for 1965-2012, and the previous 5 year average (2007 to 2011).

Sources of Uncertainty

There is no independent index of recruitment.

The sizes of the recruiting 2009 and 2010 year-classes are unknown but made up 12% by number of the catch at age 2 in 2011 and 25% by number at age 2 in 2012.

The mechanisms causing changes in fish weight-at-age are not understood.

The assumption that the surveys are additive continues to be a source of uncertainty (DFO 2007).

The advice uses relative trends in spawning stock biomass and exploitation rate because there is no accepted analytical assessment model. This creates a difficulty in putting current SSB in a historical context as acoustic data only exists for 1999-2012.

CONCLUSIONS AND ADVICE

The conclusions for this stock are drawn from the observations described in the stock trends and current status section.

This assessment indicates an increase from the lower level observed in 2005-2010. The overall biomass estimates have increased in 2011 and 2012; however, most of this growth has occurred in Scots Bay. The German Bank SSB fluctuated up in 2011 and down in 2012, representing essentially no change.

The three-year moving average increased above the limit reference point in 2010, changed very little in 2011, and increased again in 2012.

A harvest strategy which continues to exercise caution is appropriate.

OTHER CONSIDERATIONS

Observer reports of by-catch in purse seine sets have reported very small amounts of non-herring species, most of which are released unharmed.

ASSESSMENT, CONCLUSIONS AND ADVICE FOR OTHER COMPONENTS

Offshore Scotian Shelf

Since 1996, a fishery has taken place on feeding aggregations on the offshore banks of the Scotian Shelf, primarily in May and June, with catches ranging from 1,000 to 20,000t (Figure 10). In 2011, total landings were above average at 10,455t, down from 11,862t in 2010. In 2012, only 1,210t were landed from the offshore. Most landings were caught by purse seiners in May and June, in the vicinity of the Patch and Emerald Basin in 2011, and from the Patch, Western Hole and French Bank in 2012. Additional by-catches (27t in 2011, 45t in 2012) were reported from otter trawl fisheries for groundfish and silver hake on the Scotian Shelf.

In 2011 and 2012, the age composition of the catch was mostly adult herring with age 6 (33%, 2011; 27% in 2012) dominating by number and weight (Figure 11).

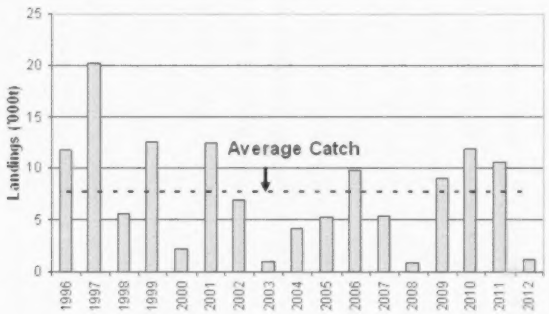

Figure 10. Offshore Scotian Shelf herring landings since 1996 with overall average for the period.

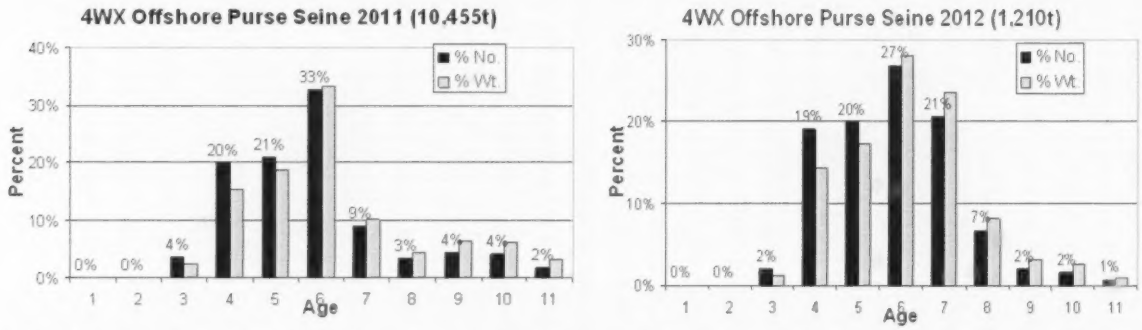

Figure 11. Fishery catch at age (% numbers and % weight) for the 2011 and 2012 Offshore Scotian Shelf herring component.

No industry surveys were conducted on the offshore Scotian Shelf in 2011 or 2012. The DFO summer ecosystem trawl survey index, which previously demonstrated considerable abundance of herring widely spread over the Scotian Shelf, decreased substantially from a high in 2010 of 300 fish per tow to 71 (2011) and 108 (2012). The bottom trawl data are not considered

indicative of overall herring abundance but are useful to document herring distribution and biological attributes such as size, age, maturity and condition.

There was no new information and no reason to change the recommendation that the initial catch allocation for 2013 should not exceed 12,000t as described in the DFO management plan. The industry is again encouraged to explore and undertake structured surveys of the offshore area.

Coastal (South Shore, Eastern Shore and Cape Breton) Nova Scotia

There is no quota for the coastal Nova Scotia spawning component. Apart from the four areas indicated in Table 4, the size and historical performance of various spawning groups are poorly documented. In addition to the traditional bait and personal-use fisheries, directed roe fisheries have occurred on several spawning grounds since 1996.

Table 4. Recorded landings and allocations (tonnes) of herring from major gillnet fisheries on the Coastal Nova Scotia spawning component for 1996 to 2012.

Landings & Allocations (t)		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Little Hope/Port Mouton	Catch		490	1,170	2,920	2,040	2,900	3,980	4,500	1,300	2,240	3,140	1,510	1,108	3,731	3,106	2,564	2,150
	Allocation					1,495	1,170	1,410	2,248	3,028	3,162	3,952	4,008	2,944	2,172	2,454	2,094	2,188
Halifax/Eastern Shore	Catch	1,280	1,520	1,100	1,630	1,350	1,900	3,330	2,700	4,200	3,450	3,350	3,730	2,381	6,045	2,456	1,040	799
	Allocation					1,425	1,313	1,403	1,952	3,638	3,802	4,323	5,367	5,103	3,857	4,373	4,188	2,920
Glace Bay	Catch		170	1,730	1,040	830	1,200	3,060	1,900	1,500	630	85	45	12	4	11	0	7
Bras d'Or Lakes	Catch	170	160	120	30	56	0	1	4	0	0	0	0	0	0	0	0	0

Landings and allocations in the Little Hope/Port Mouton area have decreased since 2009 (Table 4). In 2011, 2,564t were landed against an allocation of 2,094t and in 2012, 2,150t were landed against an allocation of 2,188t. Landings decreased from 6,045t in 2009 to 799t in 2012 in the Eastern Shore area while the allocation also decreased from 3,857t to 2,920t during the same time period. Allocations in 2011 and 2012 were based on the recent five year average of observed acoustic biomass. Landings were minimal for Glace Bay with no catch in 2011 and 7t in 2012. The Bras d'Or Lakes area remained closed to herring fishing. In 2011 and 2012, the age composition of the catch for the coastal component was primarily adult herring from the size selective gillnet fishery with a substantial proportion of the catch (greater than 90%) age 5 and older (Figure 12).

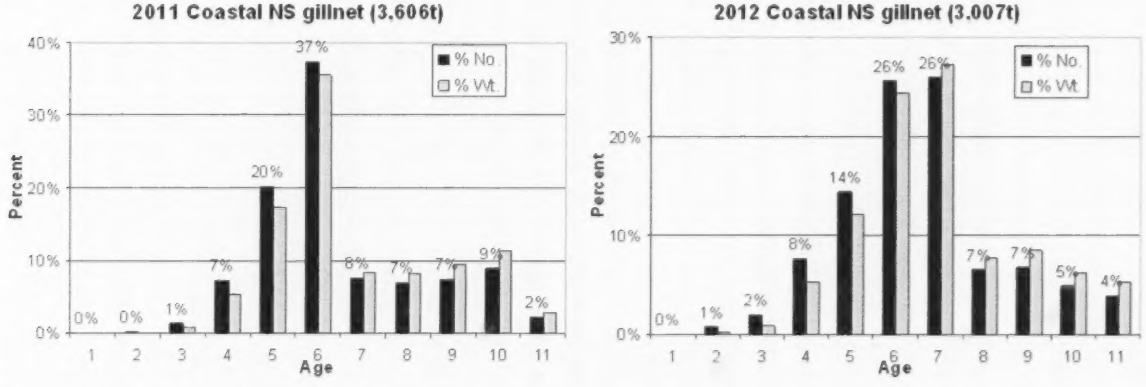

Figure 12. Fishery catch at age (% numbers and % weight) for the 2011 and 2012 Coastal Nova Scotia herring component.

As the inshore roe gillnet fisheries off Glace Bay, East of Halifax, and Little Hope developed (since 1996) participants have contributed to sampling and surveying. In 2011 the survey biomass for the Little Hope/Port Mouton area increased to 28.8kt from the 26.7kt in 2010. There

was a dramatic (55%) decrease in survey biomass to 12.8kt in 2012, the lowest since 2008 and well below the recent five year average of 24.3kt (Table 5, Figure 13). The survey biomass in the Halifax/Eastern shore area saw a large decrease in 2010 declining to 27.7kt. This trend continued into 2011 (5.5kt) and 2012 (3.7kt) to the lowest since surveys started and well below the recent 5 year average of 24.3kt (Figure 14). Only one survey was completed near Glace Bay in 2011, but there were very few spawning herring documented or reported catches (Figure 15). No herring surveys have been conducted in the Bras d'Or Lakes since 2000.

Table 5. Estimated herring acoustic SSB (thousands of tonnes) and recent 5 year average for the Coastal Nova Scotia spawning component areas.

Acoustic Survey SSB	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg last 5 years
Little Hope/Port Mouton	14.1	15.8	5.2	21.3	56.0	53.1	22.5	44.7	24.1	2.8	14.5	36.6	26.7	28.8	12.8	23.9
Halifax/Eastern Shore	8.3	20.2	10.9	16.7	41.5	92.6	28.4	37.0	68.9	28.3	30.3	54.2	27.7	5.5	3.7	24.3
Glace Bay	0.0	2.0	0.0	21.2	7.7	31.5	n/s	3.2	n/s	0.2	0.5	0.1	0.0	0.1	n/s	0.2
Bras d'Or Lakes	0.0	0.5	0.1	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

n/s - no survey

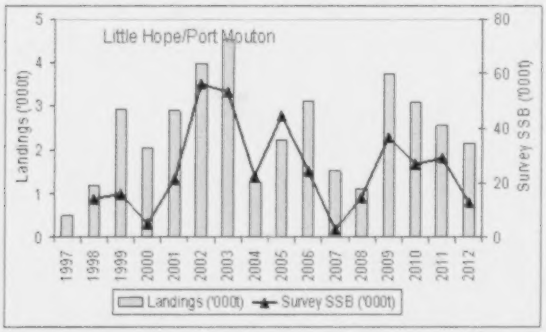

Figure 13. Landings and acoustic survey SSB ('000t) for the Little Hope/Port Mouton gillnet fishery for 1998-2012.

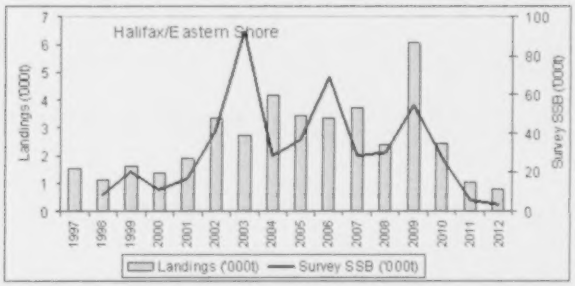

Figure 14. Landings and acoustic survey SSB ('000t) for the Halifax/Eastern Shore gillnet fishery for 1998-2012.

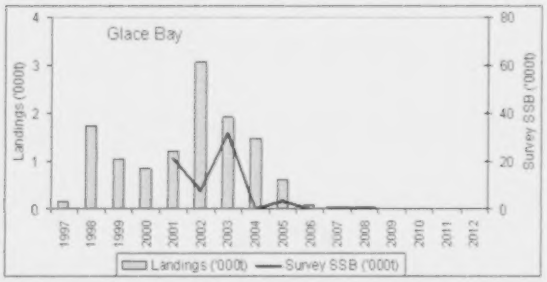

Figure 15. Landings and acoustic survey SSB ('000t) for the Glace Bay gillnet fishery for 1998-2012.

Collaborative surveys with industry have improved our knowledge of two areas (Little Hope/Port Mouton, Halifax/Eastern Shore), but there has been no increase in information from other areas. Surveying in the Glace Bay area concluded in 2011. Individual spawning groups within this component are considered vulnerable to fishing because of their relatively small size (biomass) and proximity to shore. It is again recommended that no coastal spawning group experience a

large effort increase in new areas until enough information is available to evaluate the state of that spawning group.

It has been noted since 1997 that the status of herring in the Bras d'Or Lakes is cause for concern, but there has been no research or surveying in recent years. It is; therefore, appropriate to reiterate that no fishing should take place on this spawning component.

Harvest levels from these areas use a five year average of survey biomass and/or surveyed acoustic biomass to set initial targets.

SW New Brunswick Migrant Juveniles

The southwest New Brunswick weir and shutoff fisheries have relied, for over a century, on the aggregation of juvenile herring (ages 1-3) near shore at the mouth of the Bay of Fundy. These fish are considered to be a mixture of juveniles, dominated by those originating from Northwest Atlantic Fisheries Organization (NAFO) Subarea 5 spawning components, and have, therefore, been excluded from the SW Nova Scotia/Bay of Fundy quota.

Landings in New Brunswick weir and shut-off fishery were down dramatically from 10,958t in 2010, to 3,711t in 2011 and 504t in 2012. The 2012 catch is the lowest in the history of the fishery. It is notable that as recently as 2007 landings were 30,944t, the highest in nearly 20 years and higher than the long term average of 23,560t (Figure 16). Fish caught in the New Brunswick weir and shutoff fishery were mostly juveniles (54% at age 2 in 2011 and 80% at age 1 in 2012) (Figure 17). The number of weirs with catches decreased in 2011 and 2012, with only 37 weirs reporting catches in 2011 and four weirs in 2012.

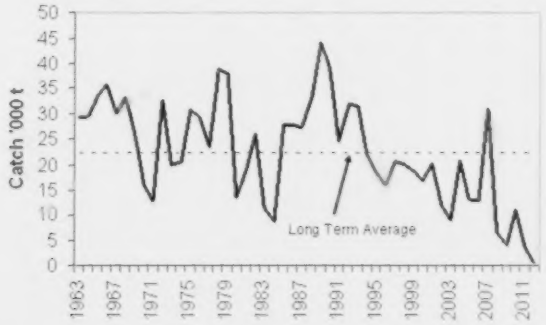

Figure 16. Herring landings from New Brunswick weir and shutoff fishery for 1963-2012 with long term average catch.

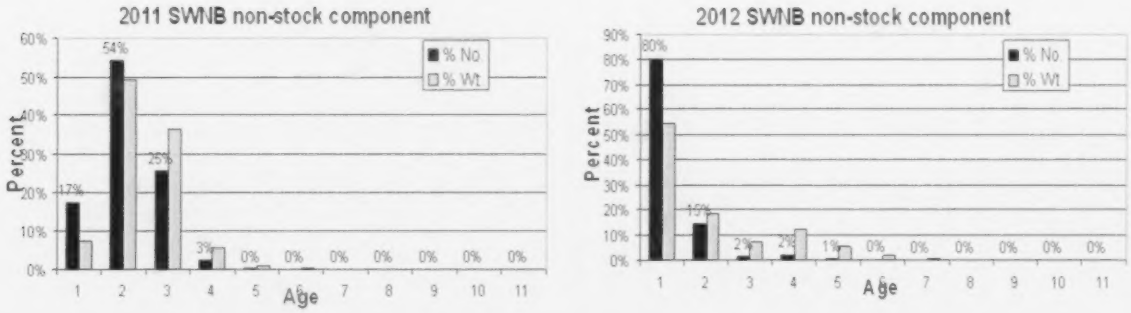

Figure 17. Fishery catch at age (% numbers and % weight) for the 2011 and 2012 SW New Brunswick migrant juvenile herring component.

The success of this passive fishery is historically unpredictable, and catches are extremely susceptible to many natural variables in addition to abundance.

SOURCES OF INFORMATION

This Science Advisory Report is from the March 26-27, 2013 Assessment of 4VWX Herring. Additional publications from this process will be posted on the Fisheries and Oceans Canada (DFO) Science Advisory Schedule as they become available.

Clark, D.S., Clark, K.J., Claytor, R., Leslie, S., Melvin, G.D., Porter, J.M., Power, M.J., Stone, H.H., and Waters, C. 2012. Limit Reference Point for Southwest Nova Scotia / Bay of Fundy Spawning Component of Atlantic Herring, *Clupea harengus* (German Bank and Scots Bay). DFO Can. Sci. Advis. Sec. Res. Doc. 2012/025. iii + 14 p.

DFO. 2003. 2003-2006 Scotia-Fundy Fisheries Integrated Herring Management Plan, NAFO subdivisions 4WX, 4Vn and 5Z. Department of Fisheries and Oceans.

DFO. 2007. Proceedings of the Maritimes Provinces Regional Advisory Process on the Assessment Framework for 4VWX Herring Stocks; 31 October – 1 November 2006 and 9 – 11 January 2007. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2007/002.

DFO. 2011. Proceedings of the Maritimes Provinces Regional Advisory Process on the Assessment Framework for Southwest Nova Scotia/Bay of Fundy Herring; 24 – 28 January 2011. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2011/031.

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